3

DGPS BROADCAST SITE CONFIGURATION

This chapter provides an overview of the subsystems and equipment that make up a DGPS broadcast site. Several of these broadcast sites will be required, strategically positioned across the country, to achieve a nationwide DGPS service. This information does not include detailed engineering drawings or specifications for the DGPS broadcast site or the required equipment. Refer to the U.S. Coast Guard "Differential GPS Broadcast Equipment Technical Manual," GCF-W-1216-DGPS, and related documents for detailed information.

3.1 DGPS System Architecture

Functionally, a DGPS broadcast site consists of several, interconnected subsystems as shown in Figure 3.1.

The function of the dual reference stations (Reference Station A and Reference Station B) is to compute corrections for GPS satellite signals and output these corrections to a radiobeacon transmitter at the prescribed radiobeacon transmitting frequency. The DGPS design incorporates redundant reference stations to provide backup in the case of a failure in one of the reference stations.

The dual integrity monitors (Integrity Monitor A and Integrity Monitor B) monitor the integrity of the broadcast DGPS correction signal. Integrity Monitor A provides integrity monitor system feedback to Reference Station A and Integrity Monitor B provides integrity monitor system feedback to Reference Station B. If either the Reference Station or Integrity Monitor of one Reference Station/Integrity Monitor pair fails, the other Reference Station/Integrity Monitor pair can be brought on-line.

The DGPS broadcast site monitor provides remote monitor and control capability for the DGPS broadcast site from the control station. Reference Station Integrity Monitor messages (RSIM) are transmitted to the control station via the X.25 communications network. RSIM messages contain information about the reference station’s health and the reference station’s confidence in the corrections generated. This information allows the control station to monitor the status of the reference station and control the operation of the redundant systems.

The packet assembler/disassembler is the communication center for all equipment at the DGPS broadcast site. All data messages between subsystems within the DGPS broadcast site and between the DGPS broadcast site and the control station are routed through the packet assembler/disassembler.

The data service unit provides the interface between the packet assembler/disassembler at the DGPS

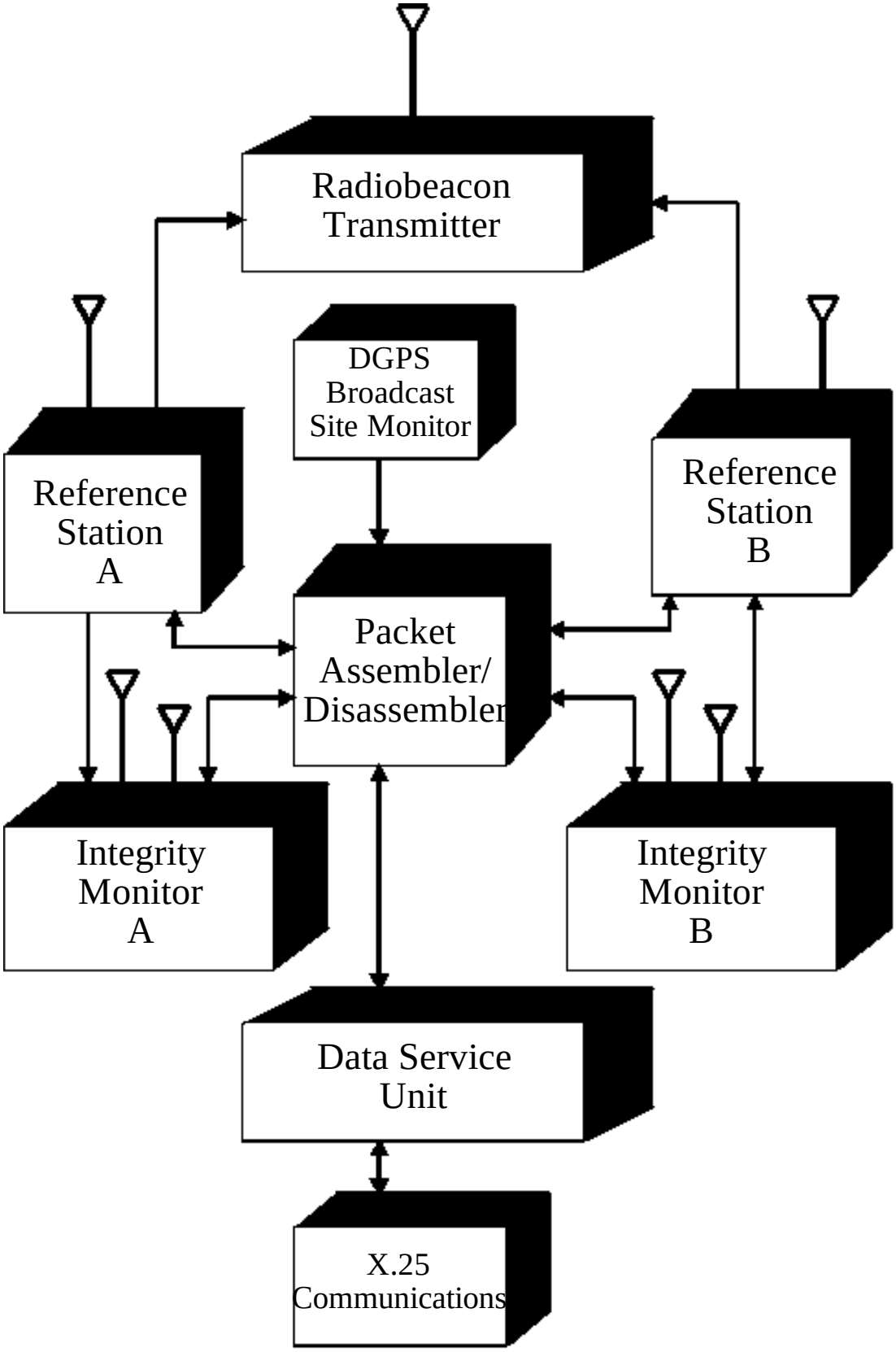

Figure 3.1. DGPS system block diagram.

broadcast site and the X.25 network to allow remote control and monitoring of the DGPS broadcast site from the control station. The data service unit is owned by the X.25 service provider (local telephone company).

The radiobeacon transmitter is the subsystem of the DGPS broadcast site equipment that amplifies and broadcasts the DGPS corrections to users in the coverage area.

3.2 DGPS Broadcast Site Equipment Relationship

Figure 3.2 shows a full DGPS broadcast site configuration and the physical connections between equipment at the site. The major components are:

(a) The DGPS equipment rack provides mounting and interconnections for the DGPS broadcast site suite of equipment.

(b) The radiobeacon equipment rack provides mounting for the radiobeacon transmitter.

(c) Reference mast 1 provides mounting for the reference station A GPS receive antenna, the integrity monitor B GPS receive antenna, and the integrity monitor B MSK receive antenna.

(d) Reference mast 2 provides mounting for the reference station B GPS receive antenna, the integrity monitor A GPS receive antenna, and the integrity monitor A MSK receive antenna.

(e) The antenna tuning unit provides the interface between the radiobeacon transmitter and the broadcast antenna.

(f) The radiobeacon antenna broadcasts the DGPS correction signal to users in the coverage area.

(g) Various environmental sensors may be connected to the DGPS equipment rack to provide monitoring of conditions at the DGPS broadcast site. These sensors include:

Intrusion sensors
Fire sensors
Temperature sensors
Humidity sensors
Power status sensors

3.3 DGPS Equipment Rack

A 19" equipment rack is installed at each DGPS broadcast site. The rack is designed to reduce electromagnetic interference (EMI) from external electrical or electronic devices or systems by 30

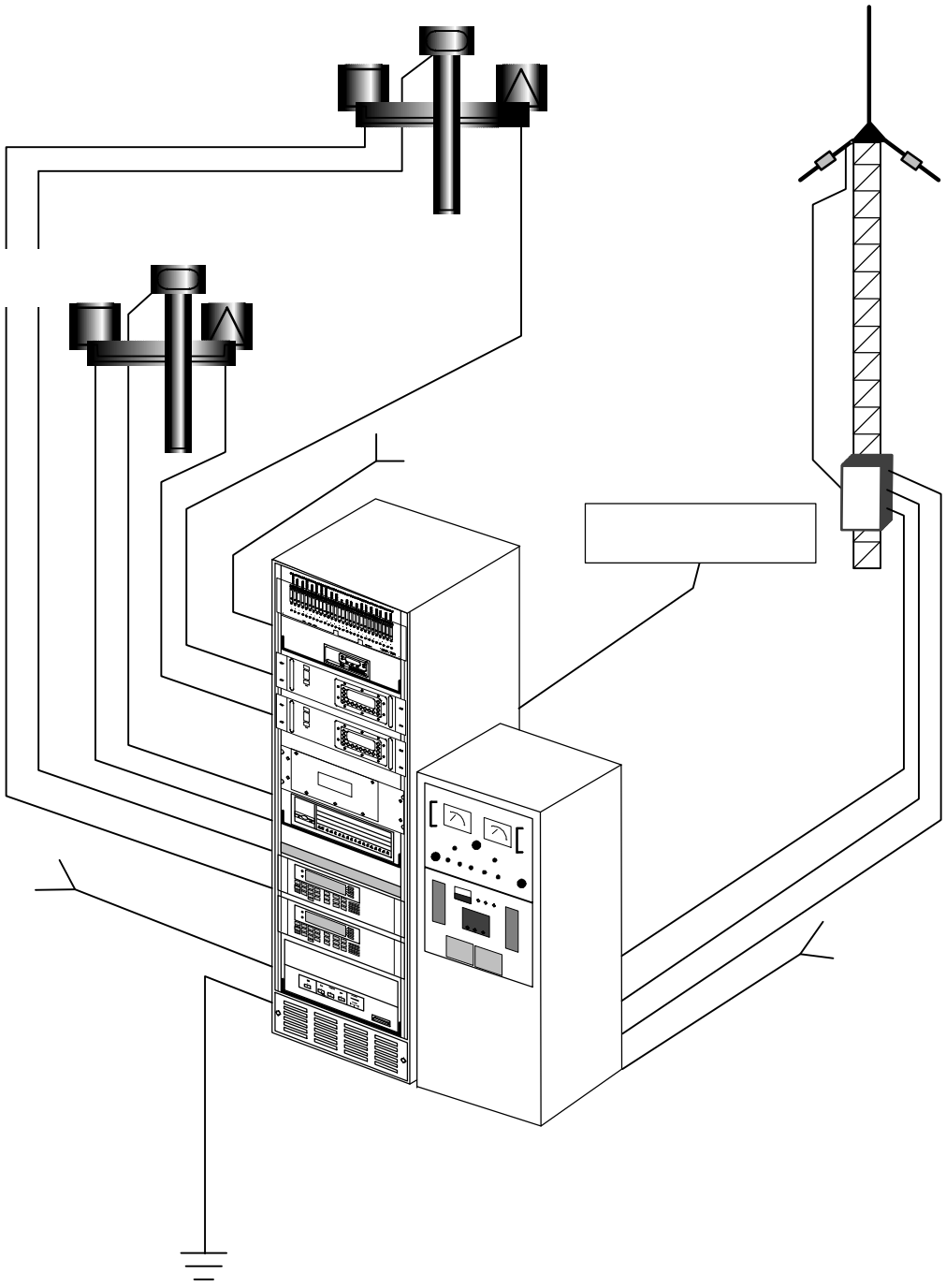

Figure 3.2. DGPS broadcast site equipment relationship.

decibels (dB). All DGPS broadcast site equipment is installed in this rack except reference masts and associated components, the radiobeacon transmitter, the broadcast antenna and associated components, and the various environmental sensors. A 300 cubic foot per minute fan is mounted on the bottom front of the rack and provides cooling air to all installed DGPS equipment. See Figure 3.3 for equipment layout within rack. A description of each component mounted in the rack is given below.[8]

Input/Output (I/O) Panel
The input/output panel contains sixteen digital input modules and eight output modules. Its function is to provide sensor input and control output for the DGPS broadcast site monitor. Sensor input and control output are provided through the junction panel, located directly behind the input/output panel.

Junction Panel
The junction panel's main purpose is to transfer input and output interconnection points to the top rear of the equipment rack rather than the front. This panel design simplifies the input and output wire runs, improves signal grounding, allows for intrusion alarm delay relay mounting, and eases installation by providing improved access for sensor wiring.

Data Service Unit
The data service unit is owned by the X.25 service provider (local telephone company). The data service unit's purpose is to provide an interface between the packet assembler/disassembler at the DGPS broadcast site and the X.25 network to allow remote control and monitoring of the DGPS broadcast site from the control station. The data service unit receives its 110 Vac power from the relay panel, located directly behind the data service unit. The data service unit sends and receives data via a high speed data transfer cable connected to the packet assembler/disassembler. The data service unit communicates at a rate of 9600 bits per second (bps) over the X.25 network.

Relay Panel
The function of the relay panel is to allow reset/on/off AC power control of any or all of the following equipment: reference station A/B, integrity monitor A/B, packet assembler/disassembler, and data service unit, based on control station remote commands through the DGPS broadcast site monitor. The relay panel consists of a relay wired to an AC outlet for each piece of equipment mentioned above. The relay panel receives AC power from the uninterruptible power system, and control input from the junction panel.

Reference Stations A and B
The DGPS broadcast site is outfitted with two dual-frequency, 12-channel reference stations. Each reference station is composed of a GPS reference receiver and a minimum shift keying (MSK) modulator. Its primary function is to compute corrections, known as pseudorange corrections (PRC), for GPS satellite signals and output these corrections in the MSK format to a radiobeacon transmitter at the prescribed radiobeacon transmitting frequency. The DGPS design incorporates redundant reference stations. Although both reference stations provide signal input to the radiobeacon transmitter, the radiobeacon transmitter only broadcasts corrections from one reference station at a time. If one reference station fails, the radiobeacon transmitter automatically shifts to the other reference station and will continue to broadcast correction until the faulty reference station can be repaired or replaced.

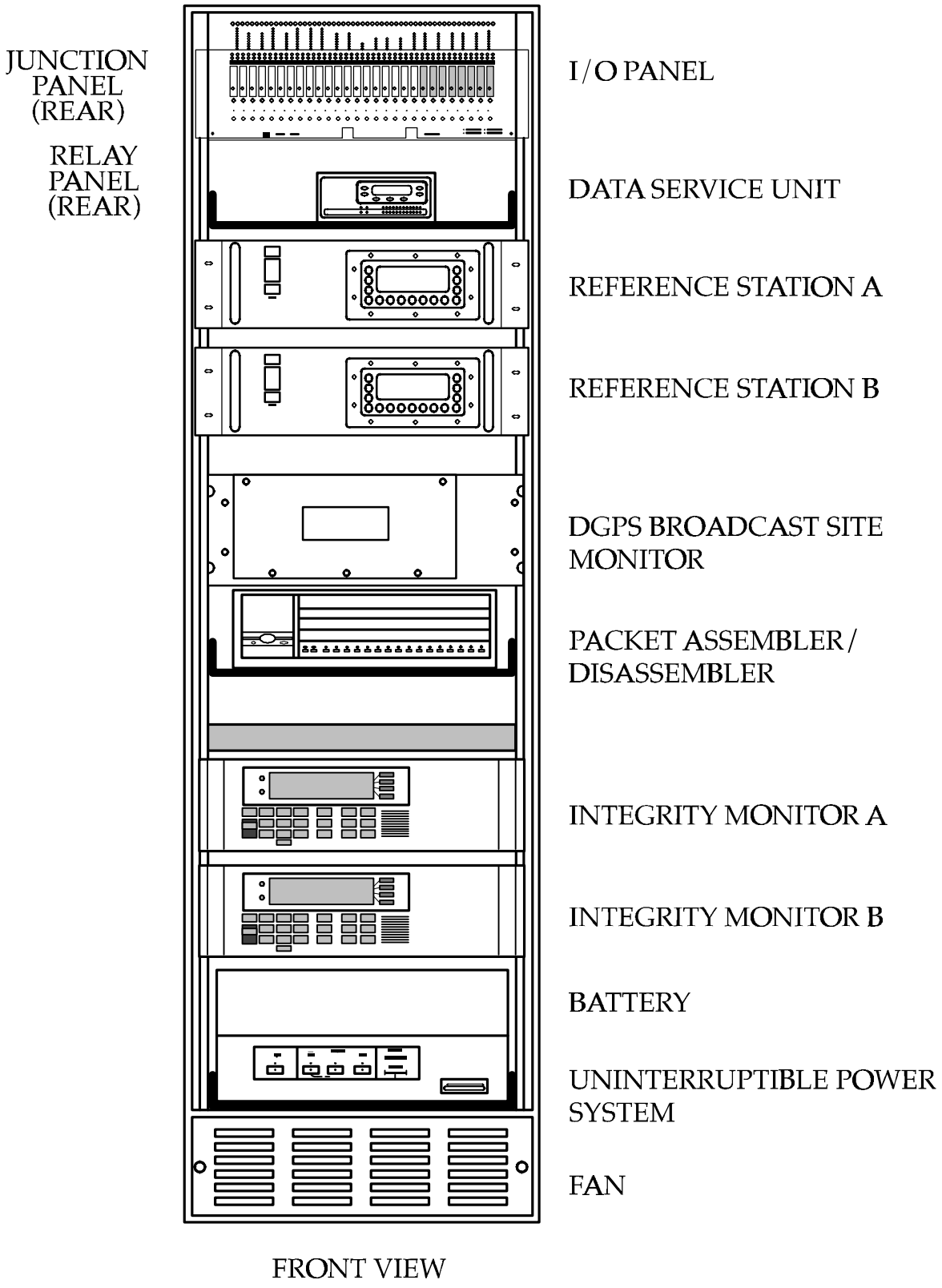

Figure 3.3. DGPS equipment rack configuration.

The reference stations receive AC power from the Relay Panel. This connection allows remote reset/on/off capabilities.

Each reference station has four communications ports to communicate with the control station and other pieces of equipment in the DGPS rack.

The reference station receives satellite information from the GPS antenna and outputs the MSK signal to the radiobeacon transmitter.

DGPS Broadcast Site Monitor

The function of the DGPS broadcast site monitor is to provide remote monitor and control capability for the DGPS broadcast site from the control station. The DGPS broadcast site monitor is the main unit of the site monitoring suite of equipment, which includes the input/output panel, junction panel, relay panel, environmental sensors, and all interconnecting cabling and wiring. The DGPS broadcast site monitor is connected by a ribbon cable to the input/output panel. The DGPS broadcast site monitor supplies 12 VDC to the junction panel. Remote control and monitoring of the DGPS broadcast site monitor is achieved through connections to the packet assembler/disassembler. The DGPS broadcast site monitor receives 110 Vac power from the uninterruptible power system.

Packet Assembler/Disassembler

The packet assembler/disassembler functions as the central communication hub for all equipment at the DGPS broadcast site. Although the packet assembler/disassembler, data service unit, and X.25 network are important for the flow of information to and from the control station, the DGPS broadcast site will still function properly if the packet assembler/disassembler, data service unit, or X.25 network fails. The packet assembler/disassembler's 110 Vac power cord is connected to the relay panel. The packet assembler/disassembler is equipped with twelve data ports. Each data port is connected to a specific communications port within the DGPS equipment rack and provides data transfer between the control station and that port.

Integrity Monitor A and B

As the name implies, the DGPS broadcast site integrity monitor monitors the integrity, or truth, of the DGPS broadcast information. Both integrity monitors monitor the MSK broadcast from the radiobeacon antenna. Integrity monitor A provides integrity monitor system feedback to reference station A and integrity monitor B provides monitor system feedback to reference station B. The integrity monitors identify their associated reference station by the reference station ID number encoded into the broadcast. If either the reference station or integrity monitor of one reference station/integrity monitor pair fails, the other reference station/integrity monitor pair can be brought on-line.

Each integrity monitor's 110 Vac power cord in connected to the relay panel. This allows remote reset/on/off control of the integrity monitors. The integrity monitor has four data ports. The integrity monitor receives satellite information from the GPS antenna, and the MSK signal from the MSK antenna.

Uninterruptible Power System
The function of the uninterruptible power system is to provide on-line uninterruptible AC power to the vital equipment located in the DGPS equipment rack. The uninterruptible power system does not provide uninterruptible power to the equipment rack cooling fan or the radiobeacon rack.

The uninterruptible power system has a battery backup unit, located directly above, which will provide a minimum of 10 minutes power at full load. A typical DGPS installation operates at approximately 20% of the uninterruptible power system's rated load. In the event of a loss in primary power, the uninterruptible power system will give the DGPS broadcast site monitor time to notify the control station of the site's power status but will not, by itself, allow the site to continue DGPS broadcasts.

The uninterruptible power system is monitored by the DGPS broadcast site monitor for AC power and inverter status. The uninterruptible power system has a bank of 4 outlets providing uninterruptible AC power and 1 outlet providing filtered AC power to the reference stations, integrity monitors, packet assembler/disassembler, and data service unit indirectly through the relay panel. From another uninterruptible outlet, the uninterruptible power system provides power directly to the DGPS broadcast site monitor.

The description above is for the standard USCG DGPS broadcast site uninterruptible power system. In some installations where a DGPS broadcast site may be installed, the uninterruptible power system and battery backup unit will be available external to the DGPS equipment rack. In this case the external uninterruptible power system should be incorporated into the system to provide the functions described above.

Hand-held Terminal (not shown in Figure 3.3)
This unit provides an interface between the technician and the DGPS broadcast site monitor microprocessor. It allows the technician to observe a limited number of processor functions during normal operations. The technician may configure and/or initialize the DGPS broadcast site monitor with this terminal. The hand-held terminal connects to a jack on the front panel of the DGPS broadcast site monitor through the attached ribbon cable. The hand-held terminal should only be connected during maintenance or configuration routines. The hand-held terminal should not be left connected to the DGPS broadcast site monitor when a technician is not at the site because a power failure would interfere with the DGPS broadcast site monitor's remote monitor and control capabilities.

3.4 Radiobeacon Equipment Rack

The half-height radiobeacon rack contains the radiobeacon transmitter. The radiobeacon transmitter, antenna tuning unit, and broadcast antenna are essential to the DGPS broadcast site operation, since this is the equipment that amplifies and broadcasts the DGPS corrections to users in the coverage area. Depending on the site, the radiobeacon transmits up to 62.5, 250, or 1000 watts. Each site transmits in the single carrier mode (with no morse code identifier) on an assigned frequency between 285 and 325 kHz. The reference station MSK signal is inserted into the radiobeacon's exciter in place of the radiobeacon's center carrier crystal. Reference station A's signal is inserted into the

radiobeacon's side A exciter and reference station B's signal into the side B exciter. The DGPS broadcast site monitor handles reset/on/off control and transmit status monitoring of the radiobeacon.

The standard radiobeacon transmitter used at USCG DGPS broadcast sites is the Nautel marine radiobeacon transmitter, but the operation of the DGPS broadcast site is not dependent upon any specific type of transmitter. At some non-Coast Guard sites, MF transmitters other than the Nautel series are in use.

3.5 Reference Antenna Masts

Each site includes two reference masts, designated reference mast #1 and reference mast #2. Each reference mast supports one reference station (GPS receive) and two integrity monitor (GPS receive and MSK receive) antennas. All reference masts are either standard, (shown in Figure 3.4) or nonstandard.

There are two types of standard reference masts: a self-supporting Rohn tower, and a 60', 18" outer diameter (O.D.) steel pipe, driven 30' into the ground. The 18" O.D. reference mast is used in extremely poor soil conditions that would not adequately support the Rohn reference mast concrete foundation. Standard Rohn reference masts are either 10', 20', or 30' high.

Nonstandard reference masts are those installations in which the above reference station/integrity monitor antennas are mounted to a structure other than a standard reference mast, such as a building roof or existing tower.

3.6 Radiobeacon Broadcast Antenna

The existing DGPS broadcast sites use a variety of radiobeacon broadcast antennas, depending on the conditions at the individual site. The broadcast antenna and its associated ground plane are designed to provide the desired signal coverage from a broadcast site. An antenna tuning unit, located at the base of the antenna tower, couples the radiobeacon signal from the radiobeacon transmitter to the broadcast antenna, and is designed to match the characteristics of the individual antenna. A ground plane of radial wires, buried in the ground, is installed at each broadcast antenna. The number and length of these radials is determined by antenna characteristics and local ground conductivity. The length of the radials determine the physical plot required for the DGPS broadcast site, and in some cases require a 15-acre or greater plot.

The recommended additional DGPS broadcast sites required to complete the nationwide coverage of the DGPS correction signal are covered in chapter 5 of these guidelines. It is recommended that a majority of these sites be located at existing Ground Wave Emergency Network (GWEN) radio transmitter sites where the broadcast antenna and associated infrastructure are in place, avoiding a major expense of installing a DGPS broadcast site.

3.7 Other DGPS Broadcast Site Equipment

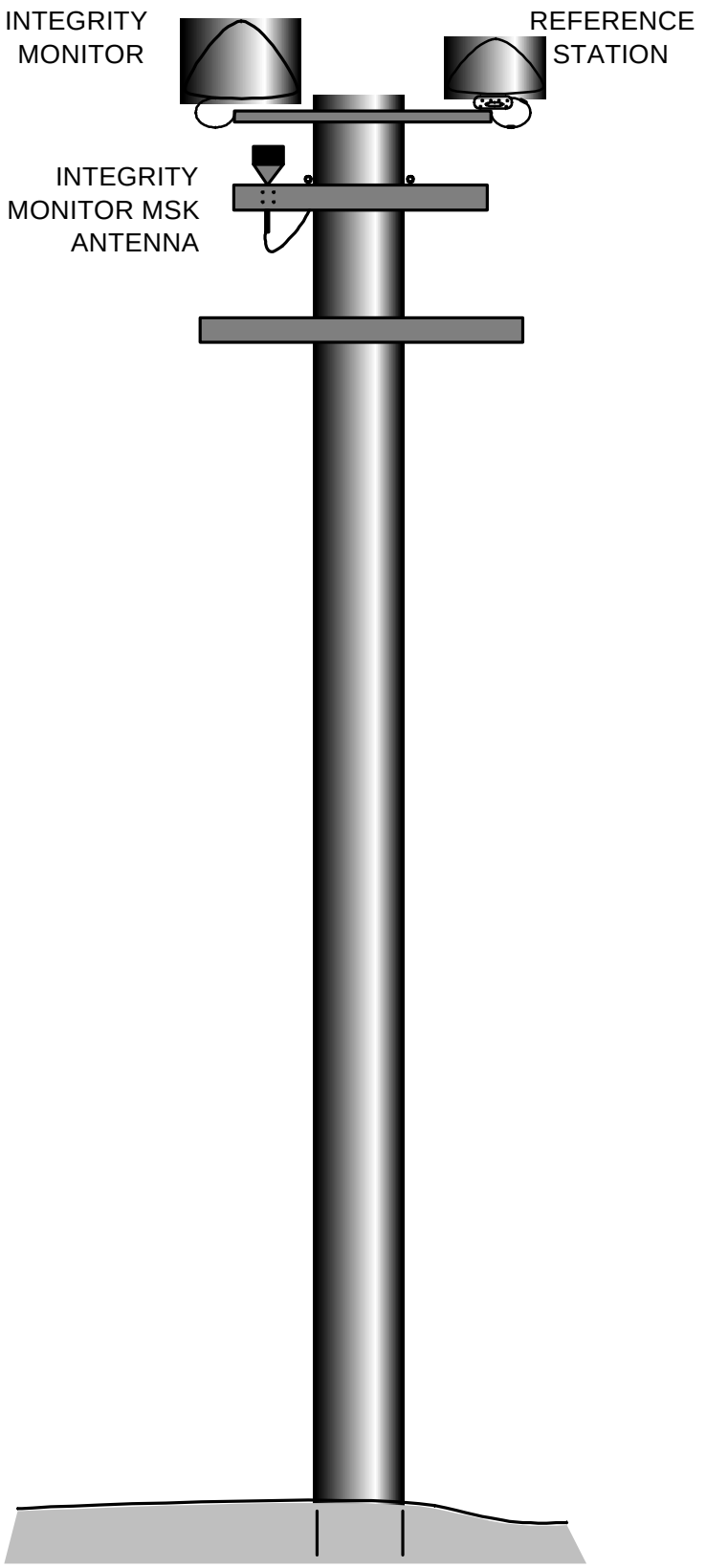

Figure 3.4. Standard reference mast and antenna mounting.

In addition to the equipment described above, there are several other pieces of equipment at the DGPS site. Some of this equipment is essential for proper operation of the DGPS broadcast site. Other equipment improves the function or reliability of the DGPS broadcast site, but is not considered essential.

Equipment Shelters
Where possible existing buildings or shelters should be utilized to house the DGPS broadcast site equipment. If a new shelter is required, a fiberglass building with dimensions: 8 feet high, 15 feet wide, and 10.5 feet deep, is recommended. Equipment shelters are available at the GWEN radio transmitter sites recommended to complete the nationwide DGPS network.

Environmental Control
Environmental controls are required at each DGPS broadcast site, designed to maintain a temperature at the DGPS equipment rack of between 40 - 90 degrees Fahrenheit and a humidity below 80 percent. The required equipment will be determined by conditions at an individual site. Environmental controls are available at the GWEN radio transmitter sites recommended to complete the nationwide DGPS network.

Emergency Generator
At sites where power is not reliable, an emergency generator should be installed to provide sufficient backup power to the radiobeacon and DGPS rack in the event of a prolonged commercial power outage. The generator should be rated between 125 and 165 percent of the site's load, including environmental controls. At the GWEN radio transmitter sites recommended to complete the nationwide DGPS network, this emergency generator is in place.

Lighthouse Power Controller
At the existing DGPS broadcast sites where an emergency generator is installed at the site, the DGPS broadcast site monitor is connected to a lighthouse power controller, providing remote monitoring of the site's power status at the control station. The function of the lighthouse power controller is to start the emergency generator upon sensing a loss of commercial power and, when the generator output is stable, provide emergency power until the return of commercial power. The lighthouse power controller provides emergency power within 4 minutes of sensing a loss of commercial power. At sites added to complete the nationwide DGPS network, a power controller would need to be interfaced to the DGPS broadcast site monitor and provide the functions described above.

Power Conditioner and Filter
A power conditioner and filter should be part of the overall site design. This equipment will mitigate potential problems caused by brownouts, power fluctuations, and noise on the commercial power line.

Fire Detection/Suppression System
If a site is equipped with a fire detection/suppression system, the DGPS broadcast site monitor may be connected to provide remote monitoring at the control station. The DGPS broadcast site monitor is designed to monitor the fire detection status. It is not designed to provide remote control of the suppression system.

Communications/Telephone

One high speed data line is required for data service unit at the DGPS broadcast site. This is a 9600 bps, 4-wire line, as part of the X.25 Packet Switching Service, supplied by the local service provider. One voice telephone line should be available for voice communications.